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Sensory Processing Patterns and Emotion Regulation in Children Presenting with Externalizing Behaviors

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SENSORY PROCESSING PATTERNS AND EMOTION REGULATION IN CHILDREN PRESENTING WITH EXTERNALIZING BEHAVIORS

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DISSERTATION APPROVAL

This is to certify that the thesis presented to us by Melanie Levitt

on the 10 day of May, 2019, in partial fulfillment of the requirements for the degree of Doctor of Psychology, has been examined and is acceptable in both scholarship and literary quality.

COMMITTEE MEMBERS' SIGNATURES

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Abstract

Sensory processing is a neurological process that involves a child's perception, organization, and reaction to sensory stimuli. Certain groups of people, such as children diagnosed with Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD), experience more intense sensory processing patterns (Dunn, 2007). Researchers have also observed that children presenting with ASD and ADHD exhibit more externalizing scores as their sensory processing patterns become more intense or problematic (Gourley et al., 2013). However, researchers have not examined the relationship between sensory processing and externalizing behaviors in those not diagnosed with ASD and ADHD. Additionally, there are overlapping neural mechanisms between sensory processing and emotion regulation. However, there is limited research regarding the relationship between sensory processing patterns and emotion regulation. The purpose of this study was to determine if there is a predictive relationship between sensory processing patterns and externalizing behaviors, as well as between sensory processing patterns and emotion regulation. Parents of 47 children, ages six through 14 years old, completed the Child Behavior Checklist (CBCL), the Short Sensory Profile, and the Emotion Regulation Checklist. Each sensory processing pattern significantly predicted externalizing behaviors, indicating that children presenting with problematic sensory processing are more likely to engage in aggressive and rule breaking behaviors. As sensory processing patterns became more problematic, emotional dysregulation increases and the ability to regulate emotional reactions decreases. Understanding how sensory processing can impact the emotions and behaviors of the children that enter therapy, can further inform assessment, conceptualization, and intervention.

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Chapter 1: Introduction

Statement of the Problem

Sensory processing is a neurological function that is responsible for managing sensory information from within the body and the environment (Mangeot et al., 2001; Cheung & Siu, 2009; Zimmer et al., 2012). Sensory processing initially requires the perception of sensory information (Gourley, Wind, Henninger, & Chinitz, 2013). The information that is noticed is then organized by the degree and intensity of the stimuli, so the body is able to respond accordingly (Mangeot et al., 2001). The goal of sensory processing is to regulate, adaptively, the nature of our responses to sensory stimuli (Mangeot et al., 2001; Gourley et al., 2013).

Sensory processing is composed of two factors: thresholds and self-regulation (Dunn, 2007). The perception of sensory stimuli is greatly impacted by the child's threshold, the limits that stimuli must meet or exceed in order for children to attend to sensory information. These limits are idiosyncratic and may be different for each sense; for instance, a child may have a high threshold for auditory stimuli and a low threshold for tactile input. Children's reaction to sensory input is influenced by self-regulation, which refers to their approach regarding sensory information (Dunn, 2007). Self-regulatory approaches may include actively engaging with their external environment or passively allowing their environment to act on them. Similar to thresholds, self-regulation is individual to the child and to the sense. Dunn (2007) studied the combinations of these factors, such as what occurs when a child has an active approach with a high threshold. Her research involved four sensory processing patterns (i.e.,

sensory seeking, sensory avoiding, sensory sensitivity, and low registration), creating a profile of commonly occurring behaviors or reactions to sensory stimuli.

The capacity to manage sensory information and responses develops over time (Zimmer et al., 2012). Sensory processing strongly influences human cognition, behavior, and learning by contributing to later development of advanced cognitions and socioemotional maturity (Dunn & Bennett, 2002; Cheng & Boggett-Carsjens, 2005). Maladaptive sensory processing can facilitate an inability to become proficient in developmental tasks (e.g. building interpersonal relationships), hindering functioning in children (Van Hulle, Schmidt, & Goldsmith, 2012).

Jean Ayres (1964) first identified sensory processing impairments, which generally occur when neurons are not signaling accurately (Van Hulle, Schmidt, & Goldsmith, 2012; Zimmer et al., 2012). According to Ayres, impaired sensory processing is related to maladaptive social, motor, and emotional regulation (Zimmer et al., 2012). Van Hulle, Schmidt, and Goldsmith (2012) noted that children who present with maladaptive sensory processing can also exhibit symptoms of other disorders, for example ASD. Independent sensory processing dysfunctions and disorders have also been identified including postural disorder and dyspraxia, which are sensory-based motor disorders (Zimmer et al., 2012). However, there is a debate about whether or not there is enough data to support sensory processing dysfunction as independent disorders or whether sensory processing dysfunction is a transdiagnostic phenomenon (Van Hulle, Schmidt, & Goldsmith, 2012).

Research on sensory processing patterns and vulnerable populations suggest that the four patterns of sensory processing are observed across the lifespan; however, there

are distinctively more intense sensory processing patterns within vulnerable populations. Children diagnosed with ASD, ADHD, developmental delays, learning disabilities, and fragile X syndrome are vulnerable populations that often display intense and maladaptive sensory processing patterns (Dunn, 2007). Primarily, researchers have focused on the relationship between ASD and sensory processing dysfunction. Findings indicated that children presenting with ASD also present with distinct and more intense sensory processing patterns (Watling, Deitz, & Renner, 1994; Baranek et al., 1997; Kientz, & Dunn, 1997).

Recently, researchers have expanded their attention to ADHD, which is characterized by inattention, hyperactivity, and impulsivity (APA, 2013). Dunn and Bennet (2002) found significant sensory processing differences between children diagnosed with ADHD and a group of typically-developing children. Furthermore, children with ADHD have been observed to have increased difficulties with sensory processing modulation compared with typically-developing children (Mangeot et al., 2001). Cheung and Siu (2009) compared children with ASD and ADHD to typically-developing children and found that those diagnosed with ASD and ADHD presented with significantly more sensory processing deficits than typically-developing children. These results are in concordance with other related studies (Mangeot et al., 2001; Miller et al., 2001; Dunn & Bennett, 2002). Interestingly, there were no significant differences between the children diagnosed with ADHD and the children diagnosed with ASD, suggesting similar challenges in sensory processing.

Children presenting with ASD and ADHD commonly exhibit externalizing behaviors such as aggression. Some researchers have explored the relationship between

sensory processing and children presenting with ASD and externalizing behaviors (Baker et al., 2008); however, there is little research exploring sensory processing in relation to externalizing behaviors independent of ASD. Researchers examining children presenting with ADHD report high comorbidity with Oppositional Defiant Disorder (ODD) (Dunn & Bennett. 2008). Despite these comorbidity rates, researchers have not examined sensory processing and externalizing behaviors independent of ADHD. Although there is some evidence of a relationship between problematic sensory processing patterns and externalizing behaviors, there is no research to distinguish whether these findings are due to the externalizing behaviors or an to ASD or ADHD diagnosis (Cheng & Boggett-Carsjens, 2005; Ben-Sasson et al., 2009; Gourley et al., 2013).

A characteristic commonly observed in children presenting with externalizing behaviors is difficulty with emotional regulation (Mullin & Hinshaw, 2007). Simply, emotion regulation refers to the child's attempt to control his or her affective response to stimuli or triggers (Berking & Whitley, 2014). Because responding to stimuli generally involves the sensory system, Jean Ayres stated that difficulties with sensory processing can negatively impact emotion regulation (Zimmer et al., 2012). Researchers have established a relationship between sensory processing and affect. Engel-Yeger et al. (2016) explored sensory processing patterns in adults diagnosed with major affective disorders and found a connection between depressive temperaments and sensory avoidance patterns. Furthermore, Watling, Deitz, and White (2001) compared children diagnosed with ASD and typically-developing children; they found children with ASD to be more emotionally reactive. Considering the commonality of emotional regulation difficulties in children diagnosed with externalizing disorders, more research that

examines the relationship between sensory processing and emotion regulation in children who present with externalizing behaviors would be beneficial. Further understanding of the mechanisms that could contribute to externalizing behaviors, such as sensory processing, could lead to the exploration of targeted treatment approaches or interventions.

Purpose of the Study

Although there is extensive research examining the relationship between problematic sensory processing patterns and vulnerable children, literature continues to focus on sensory processing within a diagnostic constellation such as ASD and ADHD. A focus on specific problematic behaviors, such as aggressive or rule breaking behaviors, could provide more information about the behavioral impacts of problematic sensory processing. The purpose of this study is to explore the relationship between the sensory processing patterns and externalizing behaviors. Currently, children who are diagnosed with ASD often receive sensory interventions such as sensory integration therapy or occupational therapy; however, children diagnosed with an externalizing disorder are not offered the same services, despite preliminary evidence that suggests a relationship between sensory processing and ADHD. The findings of this study could potentially facilitate further understanding of sensory processing as related to externalizing behaviors, as well as inform new treatment/intervention opportunities for children who present with externalizing behaviors.

Additionally, a relationship between emotion regulation and sensory processing has been theorized through the work of Ayres. Emotion regulation has also been widely discussed in regard to externalizing disorders, including ADHD. However, current

research on emotion regulation and sensory processing has focused on adult populations or children diagnosed with ASD. Therefore, a secondary purpose of this study is to explore the theorized relationship between sensory processing patterns and emotion regulation in children presenting with externalizing behaviors.

Chapter 2: Literature Review

Sensory Processing

Sensory processing refers to the brain's way of managing sensory information (Cheung & Siu, 2009; Zimmer et al., 2012). More specifically, sensory processing is a neurological process that involves perception, organization, and reaction (Cheung & Siu, 2009; Gourley, Wind, Henninger, & Chinitz, 2013). Sensory stimuli are perceived from the environment and from internal sensations by sensory receptors (Dunn, 1997; Cheung & Siu, 2009; Zimmer et al., 2012; Gourley et al., 2013). After this information is received, the central nervous system (CNS) engages in organization and interpretation in order to plan motor output effectively, or the observed reaction (Dunn, 1997; Mangeot et al., 2001; Gourley et al., 2013). Planning the motor output requires the CNS to decide how to respond and regulate the intensity and duration of the reaction, which is referred to as modulation (Dunn, 1997; Mangeot et al., 2001). The CNS can respond in two ways, through habituation or sensitization (Dunn, 1997). Habituation occurs when the CNS acknowledges sensory stimuli as familiar and decides that a continued response is not needed. To illustrate, when most children get dressed, their bodies recognize the fabric for a moment, but this attention to the tactile stimuli ends soon after they put on their clothes. Sensitization occurs when the CNS perceives sensory input as significant or threatening, which perpetuates or increases the response. Ultimately, adaptive modulation involves regulating the balance between habituation and sensitization. Furthermore, effective modulation facilitates an increase in awareness of the environment, adaptive responses, and interactions within the environment (Mangeot et al., 2001; Cheung & Siu, 2009; Gourley et al., 2013). Adaptive sensory processing can facilitate the development of self-regulation skills and can positively

impact daily living such as increased playfulness (Bundy, Shia, Qi, & Miller, 2007; Gourley et al., 2013).

Sensory Processing Theory

Based on Winnie Dunn's theory, sensory processing is composed of a physiological and a behavioral component (Dunn, 2007). Regarding the physiological component, a threshold is a defined point that a stimulus must meet or exceed, which varies by child. When the threshold is met, the sensory input excites the nervous system, creating a physical reaction (Dunn, 2007). Considering individual differences, thresholds are conceptualized on a continuum. Higher thresholds indicate a need for increased stimulation to initiate a reaction. Children with high thresholds may not perceive sensory stimuli that other children appear to notice (Dunn, 2007). For instance, these children may not become startled, but their peers react to a loud noise. On the other side, lower thresholds indicate sensitivity to stimulation. Children who are more sensitive to sensory stimulation may perceive and react to more sensory experiences, compared with their peers. These children, for example, may become startled by a noise that their peers do not react to, or possibly perceive. Dunn (2007) noted that children may have different thresholds for each sensory input (i.e. visual, auditory, tactile, etc.).

In addition to a physiological response, there is a behavioral component to sensory processing. Self-regulation refers to the behavioral approach in reaction to the perceived sensory stimuli. Similar to thresholds, self-regulation is also conceptualized along a continuum. On one side of the spectrum, people may have a passive approach, allowing their environments to affect them. Children who engage in a passive approach,

for instance, may continue to sit in a loud room but will also be observed crying. Other children may utilize an active approach; they attempt to control stimuli and their experiences in their environment (Dunn, 2007). These children may seek sensory stimulation, for example, by walking around the room during class. Ultimately, thresholds dictate the physiological sensitivity to sensory stimuli, and self-regulation approaches control the behavioral response to sensory stimuli. Depending on the combination of sensitivity and regulation approach, a child can display one of four sensory patterns (Dunn, 2007).

Sensory processing patterns include sensation seeking, sensation avoiding, sensory sensitivity, and low registration (Dunn, 2007). Sensation seeking comprises a high threshold and an active approach to stimuli (Dunn, 2007). These children tend to be active and respond to their environments in efforts to obtain enough sensory stimulation to reach their thresholds (Dunn, 2007). These children find enjoyment in their sensory experiences, which may reinforce stimuli seeking behaviors. Therefore, these children may be observed engaging in overall high activity levels but more specifically, increased movement (i.e. walking/running), humming or other verbal stimulation, and touching objects (Dunn, 2007). Other behaviors could include decreased safety awareness, especially during play times, increased excitability, and impulses to obtain sensory stimulation (Dunn, 1997). Overall, these behaviors could interfere with these children's ability to focus on required tasks in school and at home due to distraction with new or enjoyable sensory stimuli (Dunn, 2007).

A sensation avoiding pattern occurs when there is a low threshold and an active approach to the stimuli (Dunn, 2007). Children presenting with this pattern are sensitive

to sensory stimulation and will actively and quickly move away from the stimulus (Dunn, 2007). For example, if these children are in a loud room, they will often get up and leave the room. Therefore, these children may engage in increased isolation and present with higher levels of anxiety than their peers (Dunn, 2007). In addition, these children generally prefer quiet places, and they may be labelled as "loners" by caregivers and/or teachers (Dunn, 2007). Isolating and avoiding behaviors could hinder these children's ability to complete school work and other required tasks (Dunn, 2007). Furthermore, these behaviors may result in the development of ordering behaviors, rituals, or routines in an effort to create predictability in their lives; caregivers and/or teachers of these children may also report stubbornness or controlling behaviors (Dunn, 1997).

Sensory sensitivity is composed of a low threshold and a passive approach in response to the stimuli (Dunn, 2007). These children have an acute attention toward sensory stimuli, but they often do not interact with their environment (Dunn, 2007). When they are presented with aversive stimuli (e.g. a touch on their shoulder), they will not move away but will, in fact, react (e.g., screaming) (Dunn, 2007); therefore, these children have the proclivity to be reactive to situations and their environments. Considering this approach, children presenting with this pattern may experience difficulties completing assignments due to interruptions, as well as challenges in learning from experiences (Dunn, 2007). In addition, they may present as more irritable, more demanding, more defiant, or having a short-fuse. However, these children could appear more fearful and cautious rather than oppositional (Dunn, 1997). Dunn (1997) also noted that this group tends to notice more details and small changes in their physical environments and other people's affect.

Low registration occurs when there is a high threshold and a passive approach in response to the stimuli (Dunn, 2007). Overall, these children are not aware of sensory stimuli that their peers notice. Unlike the sensation seeking group, these children do nothing to obtain sensory stimulation. Therefore, children presenting with this pattern may appear unresponsive or flat towards other people and seem unaware of their environment including signs of danger (Dunn, 2007). These characteristics may become evident by others needing to touch these children to obtain their attention or these children engaging in disordered play (Dunn, 2007). Furthermore, this group may wander from activities due to inadequate neural stimulation in order to maintain their attention to notice cues within their environment or completing a task (Dunn, 1997). Considering these features, safety concerns may also be reported from caregivers and teachers.

Although only four patterns are classified, sensory processing will present differently for each child, due to individual factors (Dunn, 2007). For instance, children diagnosed with developmental delays, such as ASD, tend to present with more intense sensory processing patterns than their typically developing counterparts. These children tend to have lower thresholds for perceiving sensory stimuli, and therefore have the proclivity to be overwhelmed with sensory information at times (Dunn, 2007). This sensitivity to stimuli can limit the desire to engage in group play or lead to disruptive behaviors such as yelling or physically aggressive movements. Furthermore, one child is not limited to one pattern; children can exhibit a different pattern for each type of sensory stimuli (Dunn, 2007). For instance, a child may exhibit sensation sensitivity regarding auditory stimulation, but sensory seeking regarding tactile stimulation.

Measurement of Sensory Processing

The Sensory Profile, which consisted of 125 items, was created to assess for various responses to daily sensory experiences. A factor analysis was conducted, based on a non-clinical sample of 1,115 children and included nine factors: sensory seeking, emotionally reactive, low endurance/tone, oral sensory/sensitivity, inattention/distractibility, poor registration, sensory sensitivity, sedentary, and fine motor/perceptual (Dunn, 1997). Dunn further classified these behaviors into specific subscales. She reported that items in the low endurance/tone, poor registration, and sedentary factors are consistent with a poor registration profile. Sensory sensitivity comprises items in the oral sensory/sensitivity, inattention/distractibility, and sensory sensitivity factors (Dunn, 1997). Items in the sensation seeking factor are consistent with Dunn's sensory seeking processing pattern, and items in the emotionally reactive factor are consistent with the sensory avoidance pattern.

Dunn also completed a discriminant analysis using a sample of children diagnosed with ASD, children diagnosed with ADHD, and children without any diagnosis (Ermer & Dunn, 1998). Dunn and colleague (1998) found that about 89 percent of the sample was accurately identified as a child with or without a diagnosis through use of the Sensory Profile. The children presenting either with ASD or ADHD demonstrated more intense sensory processing patterns, as indicated by higher scores on the Sensory Profile. Additionally, multiple studies were conducted regarding sensory processing throughout the lifespan. In total, samples included 589 infants and toddlers, 1, 115 children, and 950 adolescents and adults (Dunn & Westman, 1997; Brown et al., 2001; Dunn & Daniels, 2001; Brown & Dunn, 2002; Dunn, 2002). Results of these

studies indicated that Dunn's conceptualization of the four processing patterns is observed from infancy through adulthood. Furthermore, she noted that the scores for each sensory processing pattern created a normal distribution. This suggests that the majority of the sample experienced moderate reactions to sensory stimuli, yet other participants engaged in more or less intense responses to sensory stimuli (Dunn, 2007).

Sensory Processing and Daily Living

Sensory processing can influence the way children think and perceive, behave, and learn, which, in turn, influences their understanding of their environment and experiences (Dunn & Bennett, 2002; Dunn, 2007). A sensory pattern can hinder children's ability to participate effectively in their environment and daily life tasks (Dunn, 2007). Generally, goal-directed behavior is influenced by internal environment (i.e., central nervous system), external environment (i.e. available sensory information and experiences), and stimulus/trigger (Dunn, 1997; Stellar & Stellar, 1985). To achieve adaptive, goal-directed behavior, sensory experiences are provided by the external environment; the nervous system attends to and integrates sensory information and children attend and react to stimuli and triggers (Dunn, 1997). Children then learn from their abilities to respond to stimuli and their environment. If there is a physiological impairment or limited available sensory information/experiences, behavior has the proclivity to become maladaptive or not present; this decreases children's opportunities to learn adaptive responses and also about their environment (Dunn, 1997).

More specifically, negative sensory experiences often influence the development of interpersonal skills and self-regulation skills (Van Hulle, Schmidt, & Goldsmith, 2012). Play provides opportunities for children to establish and maintain relationships

and to develop adaptive coping to aversive stimuli. For play to be effective, children must be able to understand and act on their environment successfully (Bundy, Shia, Qi, & Miller, 2007). However, children who exhibit difficulties with sensory integration are often unable to interact effectively with their environment or with objects and people in their environment (Bundy, Shia, Qi, & Miller, 2007). Some children, for instance, may find typical group play to be too loud, so they do not engage in social interactions (Van Hulle, Schmidt, & Goldsmith, 2012). Furthermore, sensory input, specifically touch, has been linked to attention (Dunn, 2007). Interventions that apply touch pressure, such as weighted vests, and those that provide continuous sensory feedback, such as ball chairs, have demonstrated effectiveness in increasing children's attention (Dunn, 2007). Moreover, sensory processing influences children's coordination of movement (Baker, Lane, Angley, & Young, 2008). This relationship is highlighted by children diagnosed with Autism, who often display hand-flapping and other motor stimulations (Baker et al., 2008). Ultimately, early development of sensory processing contributes to later development of cognition and socio-emotional skills (Cheng & Boggett-Carsjens, 2005); therefore, an understanding of how sensory processing influences behavior and daily functioning can help inform intervention (Dunn, 2007).

Sensory Processing Deficits and Dysfunction

One way to understand the influences of sensory processing is to understand maladaptive sensory processing. Generally, children can present with deficits or dysfunction of sensory processing. A deficit occurs during the development of the sensory systems; sensory processing becomes dysfunctional when the neurons do not signal or function as expected (Zimmer et al., 2012). Specifically, there are three categories of maladaptive sensory processing (i.e. also

referred to as Sensory Processing Disorders, SPD): sensory discrimination disorder, sensory-based motor disorders, and sensory modulation dysfunction (Miller, Anzalone, Lane, Cermak, & Osten, 2007; Van Hulle, Schmidt, & Goldsmith, 2012; Zimmer et al., 2012).

Sensory discrimination disorder refers to difficulties determining characteristics of sensory stimuli (Miller et al., 2007). Children presenting with sensory discrimination disorder may also experience trouble discriminating between or among sensory stimuli (Miller et al., 2012). In other words, these children do not have the ability to define the stimuli or describe its location, although these children could tell you that a stimulus is present (Miller et al., 2012). Because these children acknowledge the presence of sensory stimuli, their ability to regulate remains, as do their reactions to the stimuli (Miller et al., 2012). As previously mentioned, discrimination deficits may occur in one or more sensory modality (Miller et al., 2012). Therefore, a child may demonstrate a discrimination deficit regarding his or her hearing; however, the child's ability to discriminate visual and tactile information is intact. Per Miller and her colleagues (2012) determined that sensory discrimination disorder more commonly affects the auditory, visual, and tactile perceptions. Impaired ability to discriminate visual and auditory information can result in learning or language difficulties, and difficulty discriminating tactile information may lead to unbalanced and uncoordinated movement (Miller et al., 2012).

Sensory-based motor disorders are subdivided into two categories: dyspraxia and postural disorders. Postural disorder refers to the inability to stabilize or control one's body (Miller et al., 2012). Children with this disorder often have the proclivity to lean on objects when standing or sitting, have poor balance, and experience difficulty regarding coordinated movement (i.e. including hand-eye coordination) (Miller et al., 2012). In addition, these children often cannot maintain the physical activity levels of their peers; therefore, they often avoid more

physically-inclined or athletic activities (Miller et al., 2012). Miller and colleagues (2012) define dyspraxia as "an impaired ability to conceive of, plan, sequence, or execute novel actions" (p. 138). Similar to postural disorders, movements may appear 'awkward' and disorganized (Miller et al., 2012). Children with dyspraxia often present with difficulties assessing distance between objects and/or people, which could result in increased accidents (i.e. may be described as accident-prone) and breaking toys (i.e. due to underestimating their force and distance) (Miller et al., 2012). In addition, some children with dyspraxia experience difficulty with fine motor skills, including oral-motor activities (e.g., eating with utensils) (Miller et al., 2012).

Sensory modulation dysfunction refers to an impaired ability to regulate and engage in appropriate reactions to sensory information (Miller et al., 2012). As previously mentioned, sensory processing dysfunction involves inefficient and inaccurate signaling of the neurons, thereby resulting in an automatic response rather than a purposeful behavior (Miller et al., 2012). Children presenting with sensory modulation dysfunction generally do not respond within the requirements of a situation; for instance, children may respond too much, respond too little, or respond when they should not (Miller et al., 2012). Furthermore, children with sensory modulation difficulties will often present with difficulties regulating attention and emotions (Miller et al., 2012). Sensory modulation dysfunction is divided into three subcategories: sensory over-responsivity (SOR), sensory under-responsivity (SUR), and sensory seeking or craving (Miller et al., 2012; Zimmer et al., 2012).

Categories of sensory modulation dysfunction. Sensory over-responsivity is characterized with having a low threshold of perceiving sensory stimuli. In other words, children presenting as over-responsive would be described as sensitive to sensory information. Physiologically, the sympathetic nervous system is increasingly activated,

ultimately triggering exaggerated “fight, flight, fright, or freeze responses” (Ayres, 1972; Miller et al., 2012, p. 137). Sensitivities can affect any of the senses. Some examples include the following: sensitive to light (i.e. visual), sensitive to touch including clothes (i.e. tactile), sensitive about food texture (i.e. oral), sensitive to noise (i.e. auditory), sensitive to smells (i.e. become distracted or feel sick) (Cheng & Boggett-Carsjens, 2005). In addition, these children may be sensitive to fast movements or directional movements (i.e. spinning in circles) (Cheng & Boggett-Carsjens, 2005). Their responses tend to occur with increased speed, intensity, and duration (Miller et al., 2012). Furthermore, these reactions hinder the children’s ability to function effectively within their environment; reactions commonly increase in unfamiliar environments/situations and when expected to transition or adjust to change (Miller et al., 2012). Parents of children with sensory over-responsivity may report higher levels of irritability, decreased socialization with peers, and inflexibility (Miller et al., 2012).

Sensory under-responsivity refers to children who often ignore sensory stimuli (Miller et al., 2012). These children have a high threshold, requiring increasingly salient stimuli to trigger awareness. Similar to an over-responsivity, sensory under-responsivity can impact any of the senses. Some examples include the following: an attraction to light or staring at an object (i.e. visual), preference for more messy or rough activities or deep pressure (i.e. tactile), enjoyment for strong tastes (i.e. oral), preference for loud settings (i.e. auditory), an attraction to smell (i.e. even those others dislike) (Cheng & Boggett-Carsjens, 2005). Contrary to an over-responsivity, these children have a proclivity to enjoy rough play, quick movements, and spinning (Cheng & Boggett-Carsjens, 2005). Children with sensory under-responsivity are often described as sluggish and do not take initiative to explore their environment (Miller et al., 2012). Of note, decreased initiative is not indicative of decreased interest or motivation; rather, it is decreased

awareness of opportunities to explore and engage with their environment. In addition, parents and teachers may report inattentiveness and difficulties in engaging their children.

Sensory seeking, or craving, is characterized by a seemingly unappeasable desire for sensory input (Miller et al., 2012). Children that present as sensory seeking use a highly active approach to obtain the craved input. Sensory seeking behaviors may appear similar to those with sensory under-responsivity. On the other hand, sensory seeking behaviors can become more intrusive and possibly dangerous. For instance, these children often do not respect social space and are often impulsive. Parents and teachers may report careless actions and attention-seeking behaviors. Engaging in some sensory seeking behaviors is developmentally appropriate; however, these behaviors consume a lot of time for children with sensory under-responsivity, and these children have the potential to become aggressive if their sensory needs go unmet. It is important to note that sensory seeking can occur with low and high thresholds. Miller and colleagues (2012) noted a child that cannot feel his or her zipper may excessively play with the zipper in an effort to obtain that sensory input.

Of note, there are continued debates regarding the status of sensory modulation impairments (Van Hulle, Schmidt, & Goldsmith, 2012). Specifically, there are questions about whether or not sensory modulation dysfunction is a symptom of other disorders, such as ASD, or are these impairments and associated behaviors its own disorder (Van Hulle, Schmidt, & Goldsmith, 2012). Researchers who argue toward a separate disorder have commented that children with sensory modulation impairments do not always present with additional symptoms of other disorders (Van Hulle, Schmidt, & Goldsmith, 2012). However, many children with sensory processing difficulties do present with symptoms of other diagnoses (Gourley et al.,

2013). Researchers have studied and observed maladaptive sensory processing within multiple, vulnerable populations such as children with anxiety, ASD, and ADHD.

Deficits in vulnerable population. Overall, sensory processing patterns have been observed throughout the lifespan in a non-clinical sample; however, researchers have also observed that these patterns increase in intensity for people in vulnerable populations (Dunn, 2007). Impaired sensory processing is associated with internalizing and externalizing behavior problems, characteristics of many mental health disorders (Gourley et al., 2013). Furthermore, Dunn (2007) stated that adaptive reactions to sensory information become increasingly difficult because children presenting with problematic sensory processing also present with symptoms of other disorders. These intense patterns have been observed occurring in children who present with specific medical conditions such as Fragile X, and psychological disorders including ASD, ADHD, schizophrenia, and developmental and learning disabilities.

ASD. In the *Diagnostic and Statistical Manual*, 5th edition (2013), ASD (ASD) is defined as persistent deficits in social communication and interactions, including reciprocity. Socially, these children generally appear uninterested in socializing with others, and when they do interact, their socialization is usually maintained by the other person. The second criteria consist of engagement in restricted or repetitive behaviors or interests (APA, 2013). Restricted or repetitive behaviors may include flapping movements, lining up objects, echolalia, inflexibility when transitioning is required, and fixation on a topic or interest (2013). It is also common for parents and teachers to report problematic sensory processing. Of note, the severity of symptoms falls along a continuum; therefore, presentations of ASD can vary greatly.

Sensory processing differences between children diagnosed with ASD and typically-developing children have been well-documented (Dunn, Myles, & Orr, 2002: Baker, Lane, Angley, & Young, 2008; Ashburner, Ziviani, & Rodger, 2008; Cheung & Siu, 2009). Specifically, children diagnosed with ASD scored significantly lower on the Sensory Profile, suggesting that these children experience more problematic sensory processing. Though significant differences in sensory processing, as measured by the Sensory Profile, have been observed between children with ASD and children without ASD, researchers have not consistently examined the same subscales of the Sensory Profile. For instance, Cheung and Siu (2008) observed significant differences on eight of the fourteen subscales, compared with Ashburner, Ziviani, and Rodger (2008), who observed significant differences on 13 subscales. Despite differing subscale analyses, common sensory processing characteristics within these samples were also observed.

Comparisons regarding movement, between children diagnosed with ASD and typically-developing children, did not indicate significant differences, suggesting appropriately developed processing and regulation (Ashburner, Ziviani, & Rodger, 2008; Baker, Lane, Angley, & Young, 2008). On the other hand, marked sensory processing patterns have been noted in multiple studies. For instance, Tomchek and Dunn (2007) evaluated a sample of 281 children diagnosed with ASD and 281 typically developing children and observed a decreased ability for children diagnosed with ASD to filter auditory information. In other words, these children perceive sounds that others cannot and have difficulty attending to required auditory information while ignoring background noise. Researchers have observed that children diagnosed with ASD often exhibit a combination of sensory over-responsivity and sensory under-responsivity, resulting in changing states of sensitivity and under arousal (Dunn, Myles, &, Orr, 2002; Cheng & Boggett-

Carsjens, 2005; Ashburner, Ziviani, & Rodger, 2008). Regarding children with impaired auditory filtering, for example, at times they may appear sensitive and negatively react to auditory input, and at other times they are distracted by background noise and may ignore required information. Overall, instability in arousal hinders these children's ability to process sensory input effectively and regulate their reactions (Cheng & Boggett-Carsjens, 2005).

ADHD. ADHD is defined as a persistent difficulty to sustain attention and/or persistently engage in high levels of activity (APA, 2013). This pattern of behavior is considered problematic when the child's daily functioning is impeded. Inattention can manifest in multiple ways, for instance, in wandering and in difficulty staying on task (APA, 2013). Hyperactivity is defined as excessive movement (APA, 2013). Children exhibiting hyperactivity may be observed as restless or fidgety. Some children diagnosed with ADHD also present as impulsive or engaging in actions without thought. Impulsive actions could be answering immediately or before the question is finished, as well as running into the street. Reports regarding children with ADHD often cite an inability to sit still or stay in their chairs or classrooms. Reynolds and Lane (2009) note that ADHD can also present with fluctuating moods and inflexibility, characteristics also observed in some children with intense sensory processing patterns.

Studies comparing sensory processing in children with and without ADHD have generally examined groups of children ages three to fifteen years old (Mangeot et al., 2001; Dunn & Bennett, 2002). Overall, researchers reported significant differences between children diagnosed with ADHD and typically-developing children. Dunn and Bennett (2002) also reported moderate to large effect sizes regarding significant differences between the two groups on all 14 sections of the Sensory Profile. Researchers have observed more intense and problematic sensory processing patterns in children diagnosed with ADHD, compared with

children without a diagnosis (Cermack, 1991; Parush et al., 1997; Miller et al., 2001; Mangeot et al., 2001).

Specifically, there is increased reporting that children diagnosed with ADHD present with sensitivities to sensory stimulation and exhibit trouble regulating their sensory experiences and reactions (Mangeot et al., 2001). Mangeot et al. (2001) evaluateds at 26 children diagnosed with ADHD and 30 typically developing children, and they observed significantly more sensory seeking patterns and sensitivities to touch, sound, sight, taste, and smell, based on the children's scores on the Short Sensory Profile. Additionally, Cheng and Boggett-Carsjens (2005) reported the following sensory processing concerns: over-stimulation in busy, active settings, sensitivities to auditory and/or tactile stimuli, and distraction by visual input (i.e. due to impaired capacity to filter relevant information). Furthermore, children diagnosed with a primarily inattentive type of ADHD are more likely to present with problematic sensory processing with regard to visual and tactile stimulation (Dunn & Bennett, 2002). Children diagnosed with the hyperactivity/impulsivity subtype of ADHD have a proclivity to experience difficulties regulating vestibular (i.e. system responsible for balance) sensory information. Considering sensory processing theory, children diagnosed with ADHD appear to experience difficulties accurately managing sensory information; therefore, an ability to engage in appropriate reactions to their environment is difficult, including staying in their seats during class (Cheung & Siu, 2009). These maladaptive responses are perceived as problematic behaviors related to symptoms of ADHD, such as inattention. Moreover, Neu (1997) noted that factors during infancy, such as high activity levels, decreased adaptability, and low sensory thresholds, are associated with increased ADHD diagnoses later in life.

Researchers have also observed that sensory modulation dysfunctions result in anxious presentations and inattention (Reynolds & Lane, 2009). In a study of 48 children, researchers found that children with ADHD and sensory over-responsivity presented with higher levels of anxiety, as well as increased physiological responses, than children with only ADHD (Reynolds & Lane, 20009). In addition, sensitivity regarding auditory or tactile stimuli has been correlated with an anxious and/or fearful temperament in toddlers (Van Hulle, Schmidt, & Goldsmith, 2012).

ADHD falls along a spectrum of externalizing disorders. Oppositional defiant disorder and conduct disorder are also along this spectrum and are often diagnosed in childhood. Although these disorders are along the same spectrum, only ADHD has been researched in relation to sensory processing. Due to current findings, expanding sensory processing research to other behavioral disorders would be beneficial.

Sensory-Based Interventions. There are two approaches to sensory-based treatment: impairment-oriented and performance-oriented (Polatajko & Cantin, 2010). Impairment-oriented approaches focus on the sensory-motor deficits with an aim to improve the impairment and increase adaptive functioning (Polatajko & Cantin, 2010). Interventions within this approach include sensory-based interventions (SBI) and Sensory Integration Therapy (SIT). Sensory-Based interventions consist of individualized sensory experiences or modifications to the child's environment in an effort to increased behavioral regulation (Yunus, Liu, Bissett, & Penkala, 2015). Researchers have observed behavioral improvements with SBI (Hall & Case-Smith, 2007; Roberts, King, Thomas, & Boccia, 2007; Lotan & Gold, 2009; Thompson, 2011). Specifically, Collier and Truman (2008) observed more sensory awareness, decreased aggression, decreased agitation, decreased wandering, and improved coordination. Similarly,

Schilling and Schwartz (2004) observed improvements in wandering, negative reactions to tactile stimulation, resisting the teacher, and off-task behaviors with the use of movement therapy. Additionally, researchers have observed a decrease in self-injurious behaviors with SBI (Smith, Press, Koenig, & Kinnealey, 2005). Yunus and colleagues (2015) noted that tactile intervention (e.g., massage therapy) is most often reported to help with problematic behaviors. Barnes and colleagues (2008) found small improvements in children's self-regulation, using SBI. Researchers have further reported that proprioceptive interventions, such as therapy ball chairs, can be used to improve attention and on-task behaviors (Schilling & Schwartz, 2004; Bagatelli, Mirigliani, Patterson, Reyes, & Test, 2010; Yunus et al., 2015).

Sensory Integration Therapy is based on Ayres' sensory integration theory. In SIT, children are provided with sensory-motor play activities in an effort to improve responses to sensory stimuli and increase functional behaviors within the environment (Schaaf, Dumont, Arbesoman, & May-Benson, 2018). In a review of 27 studies, SIT was found to help with reading skills, sensory-motor skills and planning, positive social interactions, behavior regulation, and focus (May-Benson & Koomer, 2010). Schaaf and colleagues (2018) conducted a review of studies that most closely followed the SIT manual and found five studies out of 109 abstracts that met their inclusion criteria. In these five studies of children diagnosed with ASD, the researchers observed improvement in play, better scores on the Goal Attainment Scale, better scores on the Social Responsiveness Scale, and increased sensory-motor functionality. Similarly, Linderman and Steward (1999) observed increased positive social interactions and activity levels in children diagnosed with Pervasive Developmental Disorder (PDD) after receiving SIT. Researchers have further observed increased participation and decreased

reactions to sensory stimuli with the use of SIT (Schaaf & Nightlinger, 2007; Schaaf, Hunt, & Bonevides, 2012)

Performance-oriented approaches focus on teaching skills to directly improve the ability to participate and complete desired activities (Polatako & Cantin, 2010). Two performance-oriented approaches include direct skills training and cognitive-based approaches (Polatako & Cantin, 2010). Direct skills training focuses on teaching only the skills for the target activity or desired behavior, which can be completed through direct service with the child or through consultation with caregivers or teachers (Polatako & Cantin, 2010). Consultation was found to be beneficial in providing individualized intervention options and goal attainment in direct skills training (Kemmis & Dunn, 1996; Sugden & Chambers, 2003). Regarding direct-service, most studies integrated a performance-oriented and impairment-oriented approach (Polatako & Cantin, 2010). Cognitive-based approaches focus on teaching cognitive skills to help facilitate learning the identified activity or behavior. Cognitive Orientation to daily Occupational Performance (CO-OP) focuses on skill building with the use of guided discovery and other cognitive strategies with the goal to apply and generalize the skills to their environments (Polatajko & Mandich, 2004). Polatajko and Cantin (2010) found four studies, of the 20 studies included in the review that reported positive outcomes with children diagnosed with Developmental Coordination Disorder. Of note, CO-OP focuses on child-identified goals; therefore, observed gains were individualized to each participant.

Although there are some findings that suggest sensory-based approaches are effective, the literature is inconsistent and at times inconclusive (Yunus et al., 2015). Fertel-Daly and colleagues (2001), for instance, completed a study using weighted vests with an ABA design. The researchers observed improvement in focus with the weighted vests; however, the

participant's attention did not return to original levels after the weighted vests were removed. Similarly, Quigley and colleagues (2011) found no improvement of problem behaviors with the use of weighted vests. Other researchers also observed no changes in play or in challenging behaviors with the use of SBI (Watling & Dietz, 2007). Many studies present limitations due to the implementation of multiple sensory interventions, which makes it difficult to identify the mechanism of change. For example, Candler (2003) observed improvements in the participants' individual goals; however, each child received SIT and sensory diet simultaneously. Regarding behaviors, other interventions such as Applied Behavior Analysis (ABA) were found to be more beneficial with reducing challenging behaviors, compared with SIT (Devlin et al., 2011). Schaaf and colleagues (2018) noted that many studies did not include thorough assessments in their procedures; therefore, it is plausible that inappropriate interventions were employed due to not identifying specific needs of the participants. Ultimately, thorough understanding and assessment of sensory and behavioral impairments are important in order to apply the appropriate intervention, which will facilitate the child's self-awareness and decrease time used on ineffective interventions for that child (Yunus et al., 2015). For instance, medications are often used with children diagnosed with ADHD; however, Ghanizaden (2009) reported that some medications might result in, or worsen, sensory behaviors.

Childhood Externalizing Disorders

Compared with internalizing disorders (e.g. depression), externalizing disorders are characterized by behaviors that are turned outward toward the child's outside world. Per the *Diagnostic and Statistical Manual, 4th edition revised* (1994), childhood externalizing disorders include ADHD, oppositional defiant disorder (ODD), and conduct disorder (CD). Recently, ADHD was moved to neurodevelopmental disorders, the same section as ASD, although

conceptually displayed behaviors can still be considered externalizing (APA, 2013). In the *Diagnostic and Statistical Manual, 5th edition* (2013), diagnoses such as ODD and CD are considered as disruptive, impulse-control and conduct disorders, along with intermittent explosive disorder (IED).

The symptoms of Oppositional Defiant Disorder are divided into three categories: angry/irritable mood, argumentative/defiant behavior, and vindictiveness (APA, 2013). These children's affect may present as being easy to trigger and/or being frequently angry. Argumentative or defiant behaviors can include purposely breaking rules, purposely annoying others around them, blaming others for their own behavior, and/or fighting with adults (i.e. especially authority figures). In addition, these children may engage in spiteful behaviors against others. To meet criteria, children need to present with at least four of eight criteria, resulting in variable presentations of the disorder. The severity of the diagnosis is dependent on the number of settings of which the symptoms occur. Of note, the presenting behaviors cannot be displayed only in the context of sibling relationships, considering the commonalities of this familial relationship. Children diagnosed with ODD often have a second diagnosis of ADHD (2013). Furthermore, ODD can be a precursor to the development of conduct disorder, especially without intervention (APA, 2013).

Conduct Disorder (CD) is characterized by persistent acts against societal norms and rules, as well as violating people's rights (APA, 2013). Symptoms, or behaviors, of CD are grouped into four categories. First, aggression towards people and/or animals may be present and manifested in various behaviors. This category includes bullying, instigating physical altercations, past use of a weapon, past violence towards humans and/or animals, and past crimes involving confrontation of a victim. The second category is the destruction of property; i.e.,

objects are purposely damaged by any method. Third, those presenting with signs of CD may also display deceitfulness, manipulation of others, or theft that may or may not involve a victim that is present. The final category is serious violations of rules, societal or parental. Therefore, running away, truancy, and staying out past community or parental curfews are included. These behaviors will occur across multiple settings and must hinder social, occupational, and academic functioning. Furthermore, due to contemporary research, the American Psychiatric Association (APA) included a specifier to account for callous and unemotional traits (2013).

As noted in the *DSM-5* (2013), children can present with some externalizing, problematic behaviors without meeting criteria for a diagnosis. Therefore, it is important not only to understand the aforementioned symptom constellations but also to recognize characteristics of these disorders individually, such as hyperactivity, aggression, and delinquency, in order to conceptualize and treatment plan more accurately for children diagnosed with an externalizing disorder or present with subclinical levels, but still with problematic, externalizing behaviors.

Predictors of Externalizing Behaviors. Previous literature indicates that factors of the family environment and parental relationship can predict future externalizing behaviors. To start, children who exhibit an avoidant attachment pattern, especially with an uninhibited temperament, are more likely to engage in externalizing behaviors (Burgess, Marshall, Rubin, & Fox, 2003). Furthermore, parenting styles have been associated with externalizing behaviors. Warm parenting styles are associated with decreased externalizing behaviors (Reuben, Shaw, Neiderhiser, Natsuaki, Reiss, & Leve, 2016). On the other hand, harsh discipline and ineffective or inconsistent parenting are more likely to lead to externalizing behaviors (Eddy & Chamberlain, 2000; Wolchik, Sandler, & West, 2000; Keiley, Lofthouse, Bates, Dodge, & Pettit, 2003). Leve, Kim, and Pears (2005) found that harsh discipline predicted externalizing

behaviors in girls who also presented with increased impulsivity or decreased fear or shyness. Rothbaum and Weisz (1994) noted a stronger connection between parental caregiving and externalizing behaviors for boys, compared with female counterparts. Previous literature indicates parental characteristics that are associated with externalizing behaviors, including maternal unresponsiveness and maternal depression (Marchand, Hock, & Widaman, 2002; Burke, 2003). This relationship has been observed more often with males than with female peers (Shaw, Keenan, & Vondra, 1994). Leve, Kim, and Pears (2005) reported maternal depression predicted externalizing behaviors in boys with low levels of impulsivity. Parental anger was observed likely to perpetuate externalizing behaviors (Denham, Workman, Cole, Weissbrod, Kendziora, & Zahn-Waxler, 2000). Last, an environment including marital discord has been associated with increased childhood externalizing behaviors (Marchand, Hock, & Widaman, 2002; Burke 2003).

Internal factors such as temperament have also been strongly associated to externalizing behaviors (Leve, Kim, & Pears, 2005). Specifically, children presenting with increased impulsive characteristics are more likely to engage in externalizing behaviors (Zahn-Waxler, Scmitz, Fulker, Robinson, & Emole, 1996; Schwartz, Snidman, & Kagan, 1996; Shaw, Owens, Giovannelli, & Winslow, 2001). Similarly, increased activity levels and seeking new stimulation are strongly associated with increased externalizing behaviors (Tremblay, Pihl, Vitaro, & Dobkin, 1994; Zahn-Waxler et al., 1996; Becht, Prinzie, Dekovic, Van Den Akker, Shiner, 2016). Becht and colleagues (2016) found that decreased optimism, noncompliance, and high activity levels predicted aggression and rule breaking behavior, but increased expressiveness, irritability, disorganization, and perseverance predicted only aggression. Factors including noncompliance and attention seeking in infants are also strongly associated with externalizing

behaviors (Shaw, Keenan, & Vondra, 1994). Zahn-Waxler and colleagues (1996) identified decreased frustration tolerance, as well as poor impulse control and increased activity levels in children ages three or four predicted externalizing behavior when they were five years old. Additionally, researchers have explored the role of early maladaptive schemas on externalizing behaviors. Wijk-Herbrink, Bernstein, Broers, Roelofs, Rijkeboer, and Arntz (2018) found that children presenting with maladaptive schemas regarding disconnection and rejection, as well as overcompensatory coping, were more likely to engage in externalizing behaviors.

Externalizing Behaviors and Sensory Processing. Although limited, there is some literature regarding the relationship between externalizing, problematic behaviors and sensory processing. With existing knowledge, some problematic behaviors can be conceptualized as impacted and triggered by sensory processing (Devlin, Healy, Leader, & Hughes, 2011). During a case study regarding an 'explosive' child, for instance, researchers observed increased sensory-related triggers and an inability to regulate sensory input, as evidenced by results on the Sensory Profile (Cheng & Boggett-Carsjens, 2005). Overall, children presenting with higher levels of problematic behaviors, as measured by the Child Behavior Checklist (CBCL), demonstrated more maladaptive sensory processing (Van Hulle, Schmidt, & Goldsmith, 2012; Gourley et al., 2013). This suggests that as sensory processing declines, more problematic behaviors are exhibited (Gourley et al., 2013). This difference appears to occur across childhood years, as evidenced by samples ranging from ages three through eleven (Ben-Sasson et al., 2009; Van Hulle, Schmidt, & Goldsmith, 2012; Gourley et al., 2013). Additionally, researchers have observed children presenting with increased externalizing symptoms also present with higher rates of sensory over-responsivity (Ben-Sasson et al., 2009; Van Hulle, Schmidt, & Goldsmith, 2012). Specifically, Van Hulle, Schmidt, and Goldsmith sought to explore the comorbidity of

SOR and psychopathology using a sample of 970 children, and they observed a 50 percent comorbidity rate of sensory over-responsivity and an externalizing disorder, as measured by the Diagnostic Interview Schedule for Children (DISC) (2012).

Other researchers have studied sensory processing and problematic behaviors; however, the samples consisted of children presenting with ASD or ADHD. Externalizing behaviors, such as aggression, is often reported regarding children diagnosed with ASD. Baker et al. (2008) observed increased maladaptive behavioral responses in children diagnosed with ASD, who also scored poorly on the Short Sensory Profile. In addition, they noted a moderate relationship between the maladaptive behavior domain and sensation seeking, auditory filtering, and low energy scales of the Short Sensory Profile. Regarding ADHD, Mangeot et al. (2001) observed a positive correlation between sensory regulation difficulties and aggression or delinquency. Of note, some reported samples of children with ADHD have also included children with other externalizing disorders. For instance, Dunn and Bennett (2002) conducted a study on sensory processing in children, ages three to fifteen, diagnosed with ADHD and reported that these children's sensory processing was significantly different from typically developing peers. Dunn and Bennett's sample, however, contained 23 of 70 children that presented with an ADD and ODD diagnosis. Of note, Cheung and Siu (2009) noted that no significant differences were found regarding sensory processing between children diagnosed with ADHD and children diagnosed with ASD. Considering similarities with sensory processing in ASD and ADHD, further research is needed to understand more comprehensively the relationship between sensory processing patterns and specific problematic behaviors rather than diagnoses.

Ultimately, there is some evidence suggesting a link between externalizing, problematic behaviors and sensory processing dysfunctions. However, the current literature is

limited. Children that present with externalizing, problematic behaviors are more likely to present for treatment, and these behaviors present as a barrier to implement interventions and instruction (Devlin et al., 2011). In addition, disruptive and aggressive behaviors often lead to more restrictive environments, which could negatively impact quality of life. Therefore, understanding the impact of sensory processing in relation to externalizing behaviors and disorders could promote more effective intervention and assessment options (Gourley et al., 2013).

Emotion Regulation

Difficulties in controlling anger and other emotions are a commonly observed feature of children diagnosed with externalizing disorders (Gross, 1998). Researchers have found an association between poor regulation of negative emotions with externalizing behavior problems, and poor regulation of positive emotions with increased negative social behaviors (Rydell, Berlin, & Bohlin, 2003). Rydell and colleagues (2003) investigated emotion and emotionality in 151 children, using the Children's Behavior Questionnaire, and they found that low regulation of anger predicted increased externalizing behaviors. Furthermore, Cheng and Boggett-Carsjens (2005) noted that ADHD and oppositional defiant disorder are considered as a differential diagnosis when unstable emotions are observed.

Emotion regulation comprises internal and external systems (Zeman, Cassano, Perry-Parrish, & Stegall, 2006). Internally, there are physiological and cognitive processes, as well as subjective evaluations (Gross, 1998; Rydell, Berlin, & Bohlin, 2003; Zeman et al., 2006). External systems refer to observable facial expressions and behaviors (Gross, 1998; Rydell, Berlin, & Bohlin, 2003; Zeman et al., 2006). Zeman and colleagues (2006) note social and cultural factors that influence emotion regulation such as values, social context, and personal

motivation or goals. The purpose of emotion regulation is to monitor and manage emotional stimulation, including what emotion is being experienced, when the feeling is felt, and how the emotion is expressed (Gross, 1998; Rydell, Berlin, & Bohlin, 2003; Zeman et al., 2006). These processes involve a child's control of and changes in intensity, extent, latency, and arousal time of expressed emotions (Gross, 1998; Rydell, Berlin, & Bohlin, 2003). Emotion regulation may occur automatically or be an effortful process, either within or outside the child's awareness (Gross, 1998). Similar to sensory processing, individuals have a set threshold of emotions, so little stimulation is needed to trigger an emotional response in children with lower thresholds (Gross, 1998). In addition, depending on the child's capacity to regulate his or her emotions, emotions may become stronger or weaker (Gross & John, 2003). Behaviorally, emotion regulation can impact children's socialization and goal-directed behavior (Thompson, 1991; Gross & Thompson, 2007).

Development of Emotion Regulation

Emotion regulation starts to develop in infancy and continues into adulthood (Calkins, 2004). The capacity to regulate emotions adaptively facilitates later development of other self-regulatory behaviors and cognition, which are observed in childhood (Calkins, 2004; Calkins & Hill, 2007). Expression of emotion, a factor of emotion regulation, is first observable in infancy, evidenced by facial expressions of core, universal feelings (e.g. happy, sad) (Zeman et al., 2006). As toddlers, children begin to expand their range of emotion to include self-conscious feelings such as shame, embarrassment, or pride (Zeman et al., 2006). As children start preschool and early elementary school, they continue to develop the ability to differentiate expression of feelings to fit within social context as well as integration of social rules, which results in children learning that their observable emotional expression does not always correspond to their internal

experience (Zeman et al., 2006). As children age, they continue to fit their emotional expression to social context and rules. During this time children begin to recognize that other people's emotions may not be the same as their own, and that others may decide to change their emotional expressions (Zeman et al., 2006).

Development of emotion regulation is influenced by internal and external factors (Morris, Silk, Steinberg, Myers, & Robinson, 2007). During infancy and early childhood, children's capacity to regulate their emotions is often inadequate; therefore, they depend on caregivers to facilitate regulation and soothing (Thompson & Lagattuta, 2006; Zeman et al., 2006). As children age and develop, they learn from their caregiver's regulation approaches and begin to internalize the observed information (Thompson & Lagattuta, 2006). As children grow older, emotion regulation begins to transition from relying on external forces to primarily internal processes (Gross & Thompson, 2007). Children and adolescents' continued observation of others facilitate accurate evaluations of experienced emotions and consequent expression of emotion; however, as children age, they look more closely towards their peers rather than to caregivers for this information (Eisenberg, Spinrad, & Smith, 2004). Of note, emotional regulation and expression are influenced by socialization, especially gender roles (Zeman et al., 2006). Furthermore, children have an opportunity to learn self-soothing skills, as well as others' reactions to their emotional expressions (Shipman et al., 2003).

Internally, a child's emotion regulation is influenced by his or her sensory processing. Specifically, the amygdala has a primary role regarding emotionality and emotion regulation, which involves sensory information (Morris et al., 1998; Zeman et al., 2006). The amygdala receives sensory information from various parts of the brain (e.g. temporal lobe, prefrontal cortex) and is responsible for integrating and regulating this sensory information along with

motor and autonomic information (Morris et al., 1998; Zeman et al., 2006). Additionally, emotion regulation involves children's threshold for sensory stimuli and consequent reactions to stimuli (Calkins & Hill, 2007). Children's reactions to input reflect experienced emotions, which can be observed via facial expressions and vocal qualities conveying positive emotions or distress.

Poorly developed emotion regulation abilities can result in negative social development and may indicate psychopathology. Overall, children's capacity to label and manage their emotions, as well as recognizing others' emotions, is important to the development and maintenance of relationships (Zeman et al., 2006). Researchers have observed a predictive relationship between decreased emotional knowledge and reported social problems and withdrawal behaviors (Zeman et al., 2006). Furthermore, adaptive emotion regulation facilitates children's ability to maintain friendships during time of conflict; specifically, Zeman and colleagues (2006) note that children exhibiting balance between emotional expression and interpersonal goals during conflict presented with healthier relationships. Rydell, Berlin, and Bohlin (2003) observed the higher levels of prosocial behaviors were correlated with decreased anger reactivity and increased control of fear and anger.

Regarding psychopathology, maladaptive emotion regulation has been associated with various mental health conditions, including both internalizing and externalizing diagnoses (Zeman et al., 2006). According to Per Bradley's model, children have a vulnerability to feel increased arousal, and when stress is introduced and their threshold is exceeded, the high levels of arousal begins to hinder their ability to regulate their reaction and behaviors positively(2003). During these times, some children may attempt to over-control their reactions, which often results in internalizing symptoms, yet other children exhibit difficulties that result in

externalizing symptoms (Zeman et al., 2006). Of note, problematic emotion regulation often presents differently in internalizing disorders, compared with externalizing disorders. Eisenberg et al. (2001) reported that sadness, control of attention, decreased awareness of one's emotions, inhibited anger, maladaptive expression of anger or sadness, and negative coping mechanisms when angry were predictive of increased levels of depression and anxiety. On the other hand, maladaptive coping with anger and inhibition of sadness were predictive of problematic externalizing behaviors (e.g. aggression). Casey (1996) looked at 30 children, ages seven to fourteen, presenting with externalizing behaviors, as measured by the CBCL. The researcher noted that children diagnosed with ADHD tend to be more facially expressive; children diagnosed with ODD have the proclivity to be more verbally expressive, and children diagnosed with Major Depressive Disorder (MDD) tend to be the least emotionally expressive.

Process Model of Emotion Regulation

As mentioned, emotion regulation is a set of processes that result in a behavioral or affective response. According to Gross' (1998) Process Model of Emotion Regulation, there are five specific processes that occur: situation selection, situation modification, attentional deployment, cognitive change, and response modulation. Emotion regulation begins with situation selection, which refers to the choice to enter or to avoid an event. For instance, a child can decide to join a game with peers or sit alone. After choosing a situation, children can modify the event through further choices, which will later influence the emotional impact. Following the example, a child that sits alone can further decide to sit facing his/her peers or face away from them. Next, attention is focused on one portion of the situation. Therefore, in the example, the child may choose to attend to his/her friend that is playing with the group. Then, cognitive change occurs, which refers to deciding the meaning of the situation. The cognitive evaluation

of the event will trigger an emotional response that may manifest behaviorally and/or physiologically. At this point, the child could perceive the event in multiple ways including his/her friend does not want to spend time with him/her, resulting in feeling rejected and increased social isolating behaviors. Of note, these first four processes are considered to be antecedent-focused emotion regulation. Last in the process is response modulation and is considered to be response-focused emotion regulation. This step occurs after the response is already elicited, but is an opportunity for the child to modify his/her response. In the example, the child may purposely get in trouble to avoid recess and provide a reason that his/her friend is not spending time with him/her. Utilizing a process approach facilitates a better understanding of triggers, consequences, and underlying mechanisms of emotion responses and regulation (Gross, 1998).

Emotion Regulation and Sensory Processing

Cheng and Boggett-Carsjens (2005) noted that sensory processing deficits are often not acknowledged during the diagnosis process when emotion instability is present. However, deficits or dysfunctions regarding early developmental processes, such as sensory processing, can result in maladaptive emotion regulation (De Gangi, Breinbauer, Doussard-Roosevelt, Stephen, & Greenspan, 2005). Mangeot and colleagues (2001) observed associations between emotional reactions and particular sensory processing patterns via a sample of children diagnosed with ADHD, using the Leiter International Performance Scale (Leiter-P) and the CBCL. The researchers observed that these children presented with significantly different sensory processing patterns, as well as lower scores on the emotional composite on the Letier-P, compared with typically developing children. The researchers also noted significant correlations between the

Sensory Profile and the CBCL that illustrates connections between sensory processing and emotional reactions that may be observed. For instance, children that engaged in avoidance of sensory stimuli often engage in an explosive and aggressive manner. Furthermore, when children become over-stimulated, they may become anxious and they withdraw. The researchers also noted that decreased empathy or regard for others and decreased regulation of social interactions are often consequential of sensory seeking patterns.

Ultimately, researchers have recognized that descriptions of disorders, such as ADHD, acknowledge a limited capacity to regulate physiological and sensory responses, which impact emotion regulation. Considering the observed social deficits and vulnerabilities of psychopathology regarding maladaptive sensory processing or poor emotion regulation, a better understanding of a possible relationship between the two factors (i.e. sensory processing and emotion regulation) could better inform case conceptualizations and treatment planning. Despite this information, there is a limited amount of literature addressing possible associations between sensory processing and emotion regulation, especially regarding children diagnosed with externalizing disorders.

Chapter 3: Hypotheses

1. It is hypothesized that sensory processing patterns will predict externalizing behaviors, as measured by items on the CBCL. Researchers have observed positive correlations between sensory processing and externalizing behaviors (Van Hulle, Schmidt, & Goldsmith, 2012; Gourley et al., 2013)
2. It is hypothesized that there will be a significant relationship between sensory processing patterns and emotion regulation, as measured by the Emotion Regulation Checklist. Children diagnosed with an externalizing disorder often present with difficulties regulating their emotions (Gross, 1998; Rydell, Berlin, & Bohlin, 2003). Furthermore, researchers have observed a relationship between sensory processing patterns and emotional reactions in children with ADHD (Mangeot et al., 2001).
    a. Depending on the previously mentioned correlation, it is hypothesized that sensory processing patterns will predict the two subscales of the Emotion Regulation Checklist.

Chapter 4: Methods

Design

This study was a cross-sectional, correlational design. There was one group and data were collected at one point in time.

Participants

Parents of eligible children were recruited through word-of-mouth responses from other participants and through advertisements on social media platforms (e.g., Facebook and Instagram). The sample consisted of 47 children, six to 14 years of age (mean = 9.19; SD = 2.30). Twenty-seven participants were identified as female (57.45%), and 20 participants were identified as male (42.55%). Parents of two participants did not identify their child's race. Of the other 45 children, 77.78% were identified as Caucasian (n = 35); 11.11% were identified as Black or African American (n = 5); 8.89% were identified as Biracial (n = 4), and 2.22% were identified as Hispanic (n = 1). Eighty percent of the sample did not have any mental health diagnoses (n = 37). The following diagnoses were identified in the remaining eight participants: Attention-Deficit/Hyperactivity Disorder (n= 3, 6.52%), Anxiety (n = 2, 4.35%), comorbid diagnoses (n = 2, 4.35%), Oppositional Defiant Disorder (n = 1, 2.17%), and Posttraumatic Stress Disorder (n = 1, 2.17%). Regarding comorbid diagnoses, one child was diagnosed with high-functioning Autism Spectrum Disorder and PTSD, and the other child was diagnosed with ODD and Obsessive-Compulsive Disorder.

Inclusion criteria. Eligible participants were parents of a child between the ages of six to 14 years-old.

Exclusion criteria. Participants were excluded if they could not read or speak English.

Measures

Sensory Profile 2, Short Form (Dunn, 2014). The short form of the Sensory Profile 2 is a 38-item measure of sensory processing in children ages three to 14 years old. Primarily, the short form is used for research purposes. Responses are given on a 5-point Likert scale, ranging from 1 (Almost Never) to 5 (Almost Always). Scores provide information regarding the child's sensory system, behavior, and sensory patterns. For the purpose of this study, the four sensory pattern subscales will be used. The sensory pattern subscales include registration (i.e. "my child seems unaware of pain"), seeking (i.e. "my child drapes self over furniture or on other people"), sensitivity (i.e. "my child rubs or scratches a part of body that has been touched"), and avoiding (i.e., "my child resists eye contact from me or others"). Each sensory pattern subscale is composed of questions from each of the sensory system and behavior scales. Similar to the full Sensory Profile 2, this assessment measures a child's reactions to sensory stimuli, including information about how his/her sensory processing may contribute to or inhibit the child's daily functioning. The normative data for the short form included 697 children, ages 3 years old to 14 years and 11 months old. The short form has been found to have acceptable to excellent internal consistency (.79 - .93) and excellent test-retest reliability (.93-.97).

The short form is derived from the Sensory Profile 2 child form, which is an 86-item measure of sensory processing patterns in children ages birth through 14 years-old, although adolescent forms are available. There is a parent version and a teacher version

available. It has been used primarily to investigate the sensory processing in children diagnosed with ASD. Normative data for the Sensory Profile 2 was based on a sample of 1,791 children, ages from birth through 14 years and 11 months old. The sample was evenly split between male and females, and about 10 percent of the sample included children with diagnoses such as ASD and ADHD. Specifically, the Sensory Profile 2 child form has been found to have acceptable to good internal reliability (.60 - .90), moderate to good interrater reliability (.49 - .89), and good to excellent test-retest reliability (.87 - .97). Validity has been established for children diagnosed with developmental delays, ASD, and ADHD.

Emotion Regulation Checklist (Shields & Cicchetti, 1995). The Emotion Regulation Checklist is a 24-item parent-report measure that assesses children's ability to regulate their emotional experiences, as well as situational appropriateness and intensity of emotional expression (Shields & Cicchetti, 1997). Responses are given on a four-point Likert scale, ranging from 1 (Never) to 4 (Always). Scores are divided into two subscales: Emotion Regulation and Lability/Negativity (Shields & Cicchetti, 1997). The emotion regulation scale evaluates children's responses, level of empathy, and regulation strategies. For instance, a question on this scale includes, "Can modulate excitement in emotionally arousing situations" (Shields & Cicchetti, 1995). The lability/negativity scale evaluates inflexibility and emotional dysregulation (Shields & Cicchetti, 1997). A question on this scale includes, "exhibits wide mood swings" (Shields & Cicchetti, 1995). Shields and Cicchetti (1997) reported good internal reliability regarding the emotion regulation scale (.83), and excellent internal consistency regarding the lability/negativity

scale (.96). Regarding the overall score, Shields and Cicchetti reported good internal reliability (.89) (Shields & Cicchetti, 1997).

Child Behavior Checklist (CBCL). The Child Behavior Checklist (CBCL) is a parent-report measure that assesses problematic behaviors a child may exhibit (Achenbach, 1991). Responses are given on a three-point Likert scale, ranging from 0 (Not True) to 2 (Very True or Often True). Scores are divided into eight subscales: anxious/depressed, withdrawn/depressed, somatic complaints, social problems, thought problems, attention problems, rule-breaking behavior, and aggressive behavior (Achenbach, 1991; Franklin, Deitz, Jirikowic, & Astley, 2008). Overall, high scores indicate problematic behaviors. Regarding reliability, Achenbach (1991) reported good to excellent test-retest reliabilities that ranged from .82 to .95, as well as acceptable to excellent internal consistency that ranged from .62 to .96.

Procedure

Information about the study was disseminated through social media platforms (i.e., Facebook and Instagram) and through word of mouth. Interested participants were asked their child's age and also if they (parents) could read and speak English. Parents that did not meet the requirements were informed and thanked for their time. Parents that were able to participate were provided options about how to complete the questionnaires (i.e., in-person, over the phone, by mail). Completion of the questionnaires took about 30 minutes. Upon completion, participants were offered an opportunity to participate in a raffle. Those interested were asked to provide their names and contact information on an index card that was not connected with the completed measures. Two participants were randomly selected, and each received a $50 gift card.

Chapter 5: Results

Descriptive Statistics

The means and standard deviations for the sample on the sensory processing patterns from the SSP, the externalizing scale from the CBCL, and the emotion regulation and lability/negativity scales from the ERC are presented in Table 1.

Table 1 Descriptive Statistics of Measures

Measure	N	Mean	SD
SSP			
Seeking	47	10.72	6.06
Avoiding	47	15.13	8.69
Sensitivity	47	17.53	8.40
Registration	47	10.72	6.07
CBCL			
External	47	47.13	15.50
Aggressive Behaviors	47	55.51	10.37
Rule Breaking	47	53.88	5.73
Behaviors			
ERC			
Emotion Regulation	46	27.02	2.94
Lability/Negativity	46	24.37	7.06

The mean scores for each of the sensory processing patterns fall within the, *Just Like the Majority of Others* range. The following scores would start to indicate more problematic sensory processing: 18 for sensory seeking, 23 for sensory avoiding, 25 for sensory sensitivity, and 17 for registration. An average externalizing score of 47.13 indicates non elevated levels of aggressive and rule breaking behaviors; a score of 60 would begin to indicate elevated observations of these behaviors. Scores on the emotion regulation scale

range from eight to 32, with lower scores indicating increased difficulties managing positive and negative feelings. Scores on the lability/negativity scale range from 15 to 60, with high scores indicating increased emotional dysregulation.

Analysis of Hypothesis 1

A multiple regression was initially planned to test the hypothesis that sensory processing patterns will predict externalizing behaviors. To test for the assumptions of the regression, a Pearson Correlation was conducted and found multicollinearity (See Table 2). Therefore, four simple linear regressions were conducted instead.

Table 2 Correlations of Sensory Patterns

	Seeking	Avoiding	Sensitivity	Registration
Seeking				
Pearson Correlation	1.00	.831*	.840*	.762*
Avoiding				
Pearson Correlation	.831*	1.00	.842*	.747*
Sensitivity				
Pearson Correlation	.840*	.842*	1.00	.806*
Registration				
Pearson Correlation	.762*	.747*	.806*	1.00

*p<.001

A simple regression was conducted to investigate how well sensory seeking can predict externalizing symptoms. The results were statistically significant, $F(1, 45)$ =

38.399, p <.001. The adjusted R squared value was .448, so this indicates that 44.8% of the variance in externalizing symptoms can be explained by sensory seeking patterns.

A simple regression was conducted to investigate how well sensory avoiding can predict externalizing symptoms. The results were statistically significant, $F(1, 45)$ = 63.106, p <.001. The adjusted R squared value was .574, so this indicates that 57.4% of the variance in externalizing symptoms can be explained by sensory avoiding patterns.

A simple regression was conducted to investigate how well sensory sensitivity can predict externalizing symptoms. The results were statistically significant, $F(1, 45)$ = 40.897, p <.001. The adjusted R squared value was .464, so this indicates that 46.0% of the variance in externalizing symptoms can be explained by sensory sensitivity patterns.

A simple regression was conducted to investigate how well sensory registration can predict externalizing symptoms. The results were statistically significant, $F(1, 45)$ = 22.503, p <.001. The adjusted R squared value was .319, so this indicates that 31.9% of the variance in externalizing symptoms can be explained by sensory registration patterns.

Additional Analysis of Hypothesis 1. To further differentiate between externalizing behaviors, the two subscales within the externalizing scale were considered. The externalizing scale of the CBCL is composed of Rule Breaking Behavior (RBB) and Aggressive Behaviors (AB). Eight simple regressions were conducted to investigate how well each of the sensory processing patterns could explain each subscale. Each of the regressions was statistically significant, p <.001; the F and adjusted R squared values are presented in table 3.

Table 3 *F* and Adjusted R^2 Values

Measure	Rule Breaking Behavior	Aggressive Behavior
Seeking		
F	22.471	81.190
Adj R^2	.318	.635
Avoiding		
F	30.112	89.754
Adj R^2	.388	.659
Sensitivity		
F	24.146	54.529
Adj R^2	.335	.538
Registration		
F	21.998	28.924
Adj R^2	.313	.378

Analysis of Hypothesis 2

A Pearson correlation was conducted to test the hypothesis that there is a significant relationship between the four sensory processing patterns and two factors of emotion regulation, as well as to test the assumptions for a regression to test a secondary hypothesis that sensory processing pattern can predict the two scales of the Emotion Regulation Checklist. Emotion regulation was significantly correlated with seeking, r (46) = -0.602, p = .001; sensitivity, r (46) = -0.586, p <.01; avoiding, r (46) = -0.611, p <.001; and registration, r (46) = -0.509, p <.001, but not enough to indicate multicollinearity. Lability/negativity was significantly correlated with seeking, r (46) = 0.699, p <.001, and registration r (46) = 0.536, p <.001, but not enough to indicate multicollinearity. Lability/negativity was highly correlated with avoidance, r (46) = 0.831, p <.001, and sensitivity, r (46) = 0.734, p <.001; therefore, these variables could not be used in the regression.

Six simple regressions were conducted due to the multicollinearity found among the sensory processing patterns. A simple regression was conducted to investigate how well sensory avoiding can predict emotion regulation. The results were statistically significant, $F(1, 44) = 26.169$, $p < .001$. The adjusted R squared value was .359, so this indicates that 35.9% of the variance in emotion regulation can be explained by sensory avoiding patterns.

A simple regression was conducted to investigate how well sensory seeking can predict emotion regulation. The results were statistically significant, $F(1, 44) = 25.055$, $p < .001$. The adjusted R squared value was .348, so this indicates that 34.8% of the variance in emotion regulation can be explained by sensory seeking patterns.

A simple regression was conducted to investigate how well sensory sensitivity can predict emotion regulation. The results were statistically significant, $F(1, 44) = 23.061$, $p < .001$. The adjusted R squared value was .329, so this indicates that 32.9% of the variance in emotion regulation can be explained by sensory sensitivity patterns.

A simple regression was conducted to investigate how well sensory registration can predict emotion regulation. The results were statistically significant, $F(1, 44) = 15.358$, $p < .001$. The adjusted R squared value was .242, so this indicates that 24.2% of the variance in emotion regulation can be explained by sensory registration patterns.

A simple regression was conducted to investigate how well sensory registration can predict lability/negativity. The results were statistically significant, $F(1, 44) = 17.701$, $p < .001$. The adjusted R squared value was .271, so this indicates that 27.1% of the variance in lability/negativity can be explained by sensory registration patterns.

A simple regression was conducted to investigate how well sensory seeking can predict lability/negativity. The results were statistically significant, $F(1, 44) = 42.046$, $p < .001$. The adjusted R squared value was .477, so this indicates that 47.7% of the variance in lability/negativity can be explained by sensory seeking patterns.

Chapter 6: Discussion

The first aim of this study was to explore the relationship between sensory processing patterns and externalizing behaviors. Previous researchers have found that as sensory processing patterns become more problematic, externalizing behaviors increase as well (Mangeot et al., 2001; Gourley et al., 2013). Findings from this study are supportive of the previous literature because a positive correlation was observed. Not only is there a relationship between sensory processing patterns, the relationship appears predictive because each sensory processing pattern significantly predicted externalizing behaviors. Of note, previous studies were based on clinical samples, including children primarily diagnosed with ASD and ADHD; however, the current study observed consistent findings using a predominately nonclinical sample. Therefore, this relationship appears to be transdiagnostic and may generalize beyond a clinical sample. Additionally, researchers have reported observing a positive relationship between sensory processing and externalizing behaviors in children from three to 11 years old (Ben-Sasson et al., 2009; Van Hulle, Schmidt, & Goldsmith, 2012; Gourley et al., 2013). In the current sample, the average age was nine years old, which is also consistent with previous research. This current study expands upon the literature by including children up to 14 years old, consistent with Dunn's theory that these patterns are observed throughout the lifespan and not only in early childhood (Dunn & Westman, 1997; Brown et al., 2001; Dunn & Daniels, 2001; Brown & Dunn, 2022; Dunn, 2002).

Furthermore, when deconstructing externalizing behaviors into more discrete behaviors, each sensory processing pattern significantly predicted aggressive behaviors and rule breaking behaviors; however, the strength of the relationships could provide

further insight into the relationship between sensory processing and specific externalizing behaviors. For instance, a much stronger relationship was observed between sensory seeking and sensory avoidance with aggressive behaviors, compared with sensory seeking and sensory avoiding with rule breaking behaviors. The Aggressive Behavior subscale includes items such as fighting, property destruction, teasing others, and demanding attention. These behaviors require children to act, actively, on their environment. Similarly, sensory seeking and sensory avoiding are characterized by an active self-regulation approach, meaning these children actively engage with their environment in reaction to sensory stimuli (Dunn, 2002). Based on the current findings, children that present with more problematic sensory seeking and sensory avoiding patterns will tend to engage actively with their environment in an aggressive manner. This predictive relationship between sensory avoiding and aggressive behavior observed is consistent with findings from Mangeot and colleagues (2001). Of note, given the nonclinical nature of the current sample, moderate sensory processing predicted moderate levels of aggressive behaviors.

On the other hand, the rule breaking behavior subscale includes items such as lies, does not express guilt, truancy, and swearing. These behaviors appear to represent a more passive engagement with the children's environment; however, this subscale also includes items such as running away that would be considered more active. Children presenting with sensory avoiding tend to move away from aversive stimuli, increasing the occurrence of elopement and running away captured on the rule breaking behavior subscale (Dunn, 2007). Therefore, as children present with more problematic sensory seeking or sensory avoiding patterns, increased rule breaking behaviors are observed but

not to the same extent as aggressive behaviors. Of note, the rule breaking behavior subscale includes severe behaviors such as fire setting, sexual behaviors, and alcohol and drug use that may not be as readily observed in a nonclinical sample. Therefore, the nonclinical nature of the current study could have contributed to the relatively weaker relationship between sensory seeking and sensory avoiding with rule breaking behaviors.

Based on the results, children presenting with greater sensory sensitivity tend to engage in more aggressive behavior. Due to the scores being within the average range, moderate sensitivity predicted moderate aggressive behaviors. Children with sensory sensitivity are generally reactive but do not usually act on their environment (Dunn 1997; Dunn, 2007). Therefore, it might not be expected to see a strong relationship between sensory sensitivity and aggressive behaviors, based on the active nature of many of the items on the aggressive behavior subscale. However, about half of the items on the scale overlap with expected behaviors of these children when aversive stimuli are present, including defiance/disobedience, screaming, and changes in mood (Dunn, 1997; Dunn, 2007). Additionally, Miller et al. reported that children presenting with sensory over-responsivity, characterized by sensory sensitivity, tended to exhibit inflexibility (2012). It is plausible that parents interpret inflexibility as a child being stubborn, which is also captured within the aggressive behavior subscale. Children presenting with sensory sensitivity also tend to engage in more rule breaking behaviors. The rule breaking behavior subscale includes swearing; this behavior, for instance, allows children with sensory sensitivity to express experiencing an aversive stimulus but does not require them to act on their environment, consistent with Dunn's description of this sensory processing pattern (1997; 2007). The relationship between sensory sensitivity, though significant, is

not as strong as with aggressive behaviors; this again could be accounted for the nonclinical nature of the sample.

Registration patterns appear similarly related to aggressive and rule breaking behaviors. Overall, children presenting with registration are nonreactive, due to needing very salient stimuli, and are unengaged with their environment, due to a passive behavioral approach to the stimuli that are perceived (Dunn, 1997; Dunn, 2007). Specific behaviors associated with registration can include limited awareness of people talking to them and decreased awareness of their environment; affectively, these children generally appear flat (Dunn, 1997; Dunn, 2007). It is plausible that adults may perceive these children as noncompliant or defiant when the child may appear to be ignoring the adult or the directive. Furthermore, limited environmental awareness could account for wandering away from people or places and picking up items that might not belong to them, and flat affect could appear as a lack of guilt toward others. These behaviors are included within the aggressive behavior and rule breaking behavior subscales and could help to explain the relationship that was observed in this study.

The second aim of the current study was to explore the theorized relationship between sensory processing and emotion regulation. Overall, as sensory processing becomes more problematic, inflexibility and emotional dysregulation increases. Additionally, as sensory processing becomes more problematic, children's positive responses to others, levels of empathy, and regulation strategies decrease. These findings are consistent with previous literature that indicates deficits in sensory processing is related to maladaptive emotion regulation (Mangeot et al., 2001; De Gangi et al., 2005). Of note, previous literature focused on infants and toddlers or children diagnosed with

ADHD; therefore, current findings suggest this relationship is observed into childhood and in a nonclinical sample, consistent with emotion regulation theory that development extends through the lifespan and is influenced by internal, neural systems including sensory processing (Morris et al., 1998; Calkins, 2004; Zeman et al., 2006; Calkins & Hill, 2007). Specifically, children that experience sensitivities to sensory stimuli and/or actively avoid sensory stimuli are much more likely to present with inflexibility and emotional dysregulation. Similarly, researchers have observed children that present with sensory over-responsivity, which is characterized by low thresholds to sensory stimuli that triggers a fight, flight, or freeze response, are more likely to also present with irritability and inflexibility, based on parent-reports (Miller et al., 2012). Dunn (1997) reported that children presenting with sensory avoidance often seek to create predictability in their environments, which may be perceived as being stubborn or inflexible, and children presenting with sensory sensitivities are more likely to be more irritable and have a short-fuse, possibly contributing to the strong relationship observed in the current study.

Further findings of the current study indicate a predictive relationship between sensory seeking and the lability/negativity scale of the ERC. Children presenting with sensory seeking patterns are often observed engaging in high levels of activity and increased excitability (Dunn, 1997). Similarly, items that create the lability/negativity scale include being prone to outbursts of energy and modulating excitement. Based on current findings, children presenting with sensory seeking patterns are more likely to have trouble regulating their energy levels and excitement, which is consistent with the increased movement and enjoyment in sensory seeking behaviors that Dunn observed and

described in her theory (1997). Previous literature also indicates that problematic sensory processing can impact children's daily activities including increased playfulness, which is also included on the lability/negativity scale of the ERC (Bundy, Shia, Qi, & Miller, 2007; Gourley et al., 2013). Therefore, children with increased sensory seeking behaviors appear prone to excitability when interacting with their environment and with peers, which can negatively impact their daily functioning, including play. Additionally, the lability/negativity scale includes items such as responding negatively to limit setting. As mentioned, children with sensory seeking behaviors enjoy actively seeking sensory experiences; therefore, it appears these children could be more likely to respond negatively to rules and boundaries that take these opportunities away from them.

Findings further indicated a predictive relationship between sensory registration and lability/negativity. Children presenting with registration patterns tend to exhibit flat or low affect (Dunn, 1997). It is plausible that adults may observe the flat or low affect as difficulty to recover from upsetting situations, which is an item included on the lability/negativity scale. Additionally, children presenting with registration patterns often do not perceive sensory information; this includes adults speaking to them (Dunn, 1997). Therefore, these children may not perceive directives, impacting their ability to transition to different activities, and adults may believe these children are ignoring directives and negatively transitioning to different activities.

Moreover, each sensory processing pattern significantly predicted emotion regulation. In other words, children with higher sensory processing patterns appear more likely to have trouble with emotional expression and regulation of emotional responses. The emotion regulation scale includes assessment of children's verbalizations of feelings.

Based on current findings, children presenting with problematic sensory processing patterns may be less likely to verbalize when they are experiencing negative emotions. With limited ability to verbalize their emotions, these children appear more likely to communicate their feelings behaviorally through aggressive behaviors, as observed in the current sample and in previous literature (Mangeot et al., 2001).

Specifically, researchers have found that children with greater sensory seeking patterns tend to exhibit decreased empathy and more difficulty regulating social interactions (Mangeot et al., 2001). Current findings appear consistent with these findings because both empathy and reactions to social overtures are captured in the emotion regulation scale. Similarly, children presenting with sensory sensitivity tend to have more trouble socializing with peers (Miller et al., 2012). Children presenting with sensory avoidance are often described as "loners"' and are observed avoiding social situations; therefore, they may be more likely to be perceived as not responding positively to social overtures from adults and/or peers (Dunn, 2007). As noted, children presenting with registration patterns have a proclivity to exhibit flat affect, which is captured in the emotion regulation scale. Adults may perceive flat affect and minimal awareness and engagement with the environment as difficulty showing empathy toward others. Additionally, children presenting with sensory registration may be more likely not to respond positively to social overtures from peers and adults. Previous literature indicates children with sensory under-responsivity and registration tend to engage in rough or disorganized play when they do interact with others (Cheng & Boggett-Carsjens, 2005; Dunn, 2007). Adults, therefore, may perceive their limited awareness of

social overtures or their rough, disorganized attempt at play as negative reactions to peers and adults.

Limitations

This study relied on parent-report of previous diagnoses to assess the child's sensory processing, emotion regulation, and externalizing behaviors. Use only of parent-report allows for one perspective of the behaviors. This could potentially result in limited or biased information by assuming the parent objectively and accurately reported the information. Furthermore, the sample consisted of school-aged children; therefore, the children are often observed more frequently by teachers throughout the school week. Obtaining information from additional reporters could have improved this study. Moreover, the Short Sensory Profile does not provide information regarding each sense; therefore, use of the Sensory Profile 2 could improve the current study and provide further insight into the observed relationships.

Additionally, the generalizability of the findings from this study is limited. The small sample size will limit the ability to apply these findings to the overall population. Furthermore, the majority of the sample identified as Caucasian; therefore, these findings may not generalize to various ethnicities and cultures, especially those not represented (e.g., Asian). With a nonclinical sample, the majority of scores were within a normal range; therefore, the relationship observed in the current study may not be consistent within a clinical population.

Future Directions

Future researchers should continue to explore the observed relationships within a clinical sample to obtain consistent findings. Of note, exploring these relationships

beyond ASD and ADHD diagnoses could be beneficial to further the understanding of sensory processing in children. Furthermore, the current study was based on Winnie Dunn's model of sensory processing and her measure of sensory processing, the Short Sensory Profile. Future researchers may consider conducting this study based on Jean Ayres' model of sensory integration and her measure, the Sensory Integration and Praxis Test (SIPT). The Short Sensory Profile primarily measures the reaction or consequential behaviors to various sensory input; the SIPT expands the evaluation to children's perception of sensory stimuli. In addition, if children with externalizing behaviors also present with problematic sensory processing patterns, it would be helpful for clinicians to know how to intervene effectively. Although findings are inconsistent, researchers have identified potentially effective interventions (e.g., Sensory Integration Therapy). Therefore, researchers should study the effectiveness of sensory-based approaches with children that present with externalizing behaviors and problematic sensory processing. It may also be beneficial for researchers to explore sensory processing factors in the assessment of externalizing behaviors, potentially to inform behavior management interventions (e.g., ABA) to address aggressive and rule breaking behaviors. For example, assessing sensory processing factors could identify additional triggers and perpetuating factors that could further inform the behavior management approach.

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